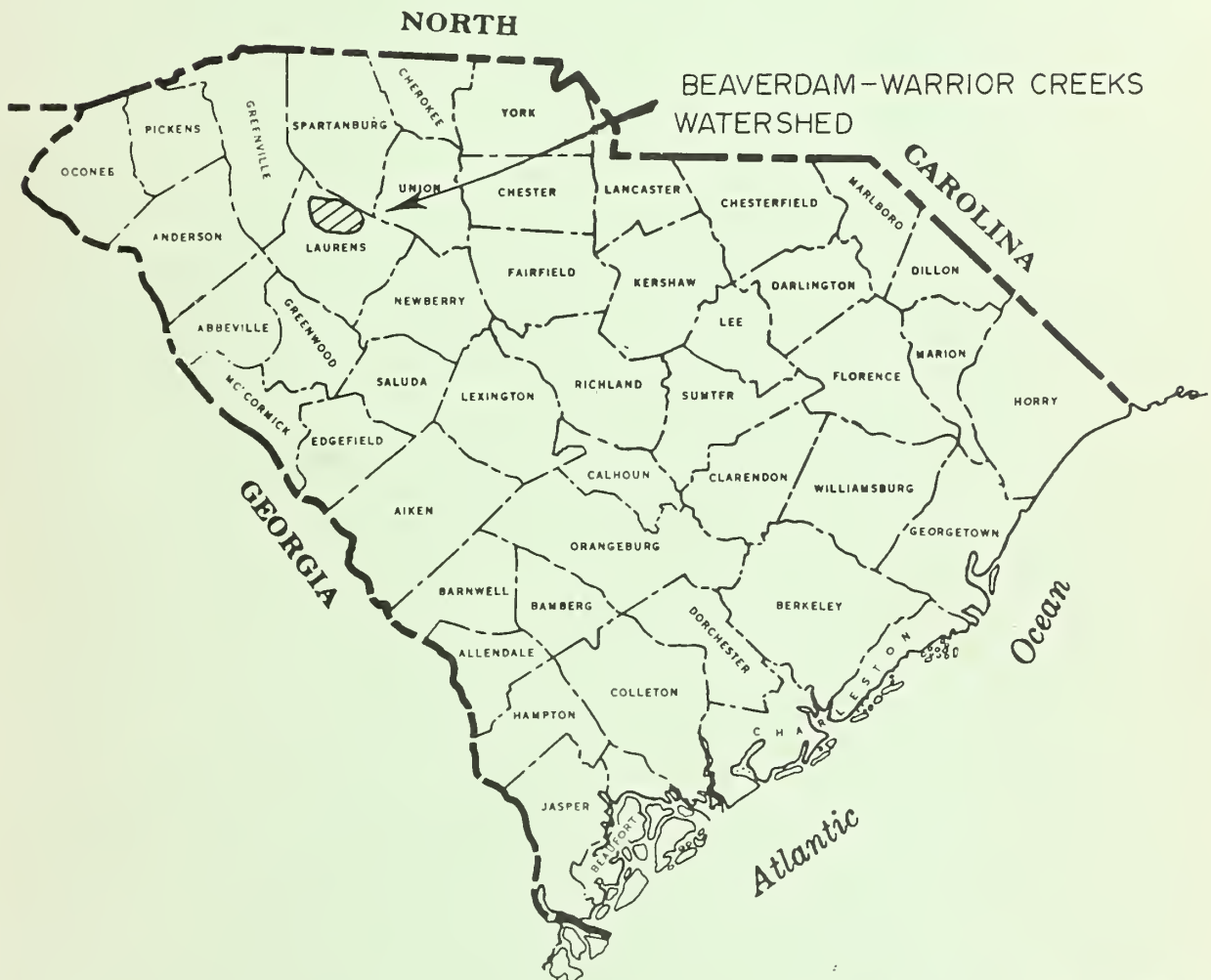


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WATERSHED WORK PLAN BEAVERDAM-WARRIOR CREEKS WATERSHED LAURENS COUNTY SOUTH CAROLINA



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	<u>Page</u>
SUMMARY OF PLAN	1
DESCRIPTION OF THE WATE	3
Physical Data	3
Economic Data	4
Land Treatment Data	6
Fish and Wildlife Re	7
WATERSHED PROBLEMS	7
Floodwater Damage	7
Sediment Damage	7
Erosion Damage	8
Problems Relating to	8
PROJECTS OF OTHER AGENC	9
PROJECT FORMULATION	9
WORKS OF IMPROVEMENT TO BE INSTALLED	10
Land Treatment Measures	10
Structural Measures	11
EXPLANATION OF INSTALLATION COSTS	14
Land Treatment	14
Structural Measures	14
Schedule of Obligations	16
EFFECTS OF WORKS OF IMPROVEMENT	16
PROJECT BENEFITS	17
COMPARISON OF BENEFITS AND COSTS	18
PROJECT INSTALLATION	19
FINANCING PROJECT INSTALLATION	20
PROVISIONS FOR OPERATION AND MAINTENANCE	21
TABLES	
Table 1 - Estimated Project Installation Cost	23
Table 1A - Status of Watershed Works of Improvement	24
Table 2 - Estimated Structural Cost Distribution	25
Table 2A - Cost Allocation and Cost Sharing Summary	26
Table 3 - Structural Data, Structures with Planned Storage Capacity	27
Table 3A - Structural Data, Channels	28
Table 4 - Annual Cost	29
Table 5 - Estimated Average Annual Flood Damage Reduction Benefits	30
Table 6 - Comparison of Benefits and Costs for Structural Measures	31
Table 7 - Construction Units	32
INVESTIGATIONS AND ANALYSES	33
PROJECT MAP	

WATERSHED WORK PLAN AGREEMENT

between the

Laurens Soil and Water Conservation District
Beaverdam-Warrior Creeks Watershed Conservation District
Upper Laurens County Water District
Town of Gray Court
Local Organizations

State of South Carolina
(hereinafter referred to as the Sponsoring Local Organizations)

and the

Soil Conservation Service
United States Department of Agriculture
(hereinafter referred to as the Service)

Whereas, application has heretofore been made to the Secretary of Agriculture by the Sponsoring Local Organizations for assistance in preparing a plan for works of improvement for the Beaverdam-Warrior Creeks Watershed, State of South Carolina, under the authority of the Watershed Protection and Flood Prevention Act (Public Law 566, 83d Congress; 68 Stat. 666), as amended; and

Whereas, the responsibility for administration of the Watershed Protection and Flood Prevention Act, as amended, has been assigned by the Secretary of Agriculture to the Service; and

Whereas, there has been developed through the cooperative efforts of the Sponsoring Local Organizations and the Service a mutually satisfactory plan for works of improvement for the Beaverdam-Warrior Creeks Watershed, State of South Carolina, hereinafter referred to as the watershed work plan, which plan is annexed to and made a part of this agreement;

Now, therefore, in view of the foregoing considerations, the Sponsoring Local Organizations and the Secretary of Agriculture, through the Service, hereby agree on the watershed work plan, and further agree that the works of improvement as set forth in said plan can be installed in about five years.

It is mutually agreed that in installing and operating and maintaining the works of improvement substantially in accordance with the terms, conditions, and stipulations provided for in the watershed work plan:

1. The Sponsoring Local Organizations will acquire without cost to the Federal Government such land rights as will be needed in connection with the works of improvement.
(Estimated cost \$107,070.)
2. The Sponsoring Local Organizations will acquire or provide assurance that landowners or water users have acquired such water rights pursuant to State law as may be needed in the installation and operation of the works of improvement.
3. The percentages of construction costs of structural measures to be paid by the Sponsoring Local Organizations and by the Service are as follows:

<u>Works of Improvement</u>	<u>Sponsoring Local Organizations (percent)</u>	<u>Service (percent)</u>	<u>Estimated Construction Costs (dollars)</u>
Multi-purpose Str. #1			
Joint Costs:	9.1	90.9	169,280
Specific Costs:			
Municipal water intake riser with pipe conduit through dam	100	0	20,700
4 Floodwater retarding structures and 36,800 linear feet of channel improvement	0	100	398,720

4. The percentages of the engineering costs to be borne by the Sponsoring Local Organizations and the Service are as follows:

<u>Works of Improvement</u>	<u>Sponsoring Local Organizations</u> (percent)	<u>Service</u> (percent)	<u>Estimated Engineering Costs</u> (dollars)
Multi-purpose Str. #1			
Joint Costs:	9.1	90.9	13,250
Specific Costs:			
Municipal water intake riser with pipe conduit through dam	100	0	1,150
4 Floodwater retarding structures and 36,800 linear feet of channel improvement	0	100	48,800

5. The Sponsoring Local Organizations and the Service will each bear their costs of project administration, estimated at \$7,410 and \$89,640, respectively.
6. The Sponsoring Local Organizations will obtain agreements from owners of not less than 50 percent of the land above each reservoir and floodwater retarding structure that they will carry out conservation farm or ranch plans on their land.
7. The Sponsoring Local Organizations will be responsible for the installation of land treatment on at least 75 percent of the major sediment source areas.

To accomplish this work, cost sharing is agreed to on increments of work as follows:

<u>Critical Area</u>	<u>PL-566</u>	<u>Other</u>
Fields		
a. For grasses and legume planting	Will furnish seeds, plants, lime, fertilizer, and needed mulch.	Apply lime, fertilizer, and mulch, prepare seedbeds, plant seeds or plants, and relocate fences where necessary.
b. For tree planting	Prepare site and plant trees.	Provide trees, needed mulch material and relocate fences where necessary.
Gullies	Will furnish materials and establish vegetation.	Slope banks, move fences and construct diversions and gully plugs as necessary.
8. The Laurens Soil and Water Conservation District will provide assistance to landowners and operators to assure the installation of the land treatment measures shown in the watershed work plan.		
9. The Sponsoring Local Organizations will encourage landowners and operators to operate and maintain the land treatment measures for the protection and improvement of the watershed.		
10. The Beaverdam-Warrior Creeks Watershed Conservation District will be responsible for the operation and maintenance of all structural works of improvement, except Structure 1, by actually performing the work or arranging for such work in accordance with agreements to be entered into prior to issuing invitations to bid for construction work. The Upper Laurens County Water District will operate and maintain multiple purpose Structure 1.		

11. The costs shown in this agreement represent preliminary estimates. In finally determining the costs to be borne by the parties hereto, the actual costs incurred in the installation of works of improvement will be used.
12. This is not a fund obligating document. Financial and other assistance to be furnished by the Service in carrying out the watershed work plan is contingent on the appropriation of funds for this purpose.

A separate agreement will be entered into between the Service and the Sponsoring Local Organizations before either party initiates work involving funds of the other party. Such agreements will set forth in detail the financial and working arrangements and other conditions that are applicable to the specific works of improvement.

13. The watershed work plan may be amended or revised, and this agreement may be modified or terminated, only by mutual agreement of the parties hereto.
14. No member of or delegate to Congress, or resident commissioner, shall be admitted to any share or part of this agreement, or to any benefit that may arise therefrom; but this provision shall not be construed to extend to this agreement if made with a corporation for its general benefit.
15. The program conducted will be in compliance with all requirements respecting nondiscrimination as contained in the Civil Rights Act of 1964 and the regulations of the Secretary of Agriculture (7 C.F.R. Sec. 15.1-15.12), which provide that no person in the United States shall, on the ground of race, color, or national origin, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any activity receiving Federal financial assistance.

Laurens Soil and Water Conservation District

By _____

Title _____

Date _____

The signing of this agreement was authorized by a resolution of the governing body of the Laurens Soil and Water Conservation District adopted at a meeting held on _____

Secretary

Date _____

Beaverdam-Warrior Creeks Watershed Conservation District

By _____

Title _____

Date _____

The signing of this agreement was authorized by a resolution of the governing body of the Beaverdam-Warrior Creeks Watershed Conservation District adopted at a meeting held on _____

Secretary

Date _____

Upper Laurens County Water District

By _____

Title _____

Date _____

The signing of this agreement was authorized by a resolution of the governing body of the Upper Laurens County Water District adopted at a meeting held on _____

Secretary

Date _____

Town of Gray Court

By _____

Title _____

Date _____

The signing of this agreement was authorized by a resolution of the governing body of the Town of Gray Court adopted at a meeting held on _____

Secretary

Date _____

viii

Soil Conservation Service
United States Department of Agriculture

By _____
Administrator

Date _____

WATERSHED WORK PLAN
BEAVERDAM-WARRIOR CREEKS WATERSHED
Laurens County
South Carolina

Prepared under the Authority of the Watershed
Protection and Flood Prevention Act (Public
Law 566, 83d Congress, 68 Stat. 666) as amended.

Prepared by: Laurens Soil and Water Conservation District
Beaverdam-Warrior Creeks Watershed Conservation District
Upper Laurens County Water District
Town of Gray Court

With Assistance By:

U. S. Department of Agriculture, Soil Conservation Service

U. S. Department of Agriculture, Forest Service

May 1969

THE WATERSHED WORK PLAN
BEAVERDAM-WARRIOR CREEKS WATERSHED
LAURENS COUNTY
SOUTH CAROLINA

SUMMARY OF PLAN

Beaverdam-Warrior Creeks Watershed includes 35,600 acres and is located approximately midway between Columbia and Greenville in north-central Laurens County.

Sponsors of the plan are the Laurens Soil and Water Conservation District, the Beaverdam-Warrior Creeks Watershed Conservation District, the Upper Laurens County Water District, and the town of Gray Court.

Floodwater and sediment damage to crops and pasture makes proper management and intensive use of the flood plain impractical. Roads, bridges and other fixed improvements are also damaged. The Upper Laurens County Water District needs water to attract industry and provide for domestic needs and future growth and development.

The objectives of the sponsors are to apply needed land treatment measures and desirable land use adjustments, to provide a minimum of 60 percent reduction of the average annual flood damages in the benefited area, and to store approximately 255 acre feet of municipal water for the Upper Laurens County Water District.

The town of Gray Court was the original sponsor for storage of municipal water. During the final stages of work plan development, the people of the area recognized the potential for distribution of water over a portion of Upper Laurens County. The Upper Laurens County Water District was created by the South Carolina Legislature on June 11, 1969, to supply and distribute water in this area, which includes the town of Gray Court, and part of Beaverdam-Warrior Creeks Watershed. The Water District has assumed the responsibility originally borne by the town of Gray Court.

The works of improvement proposed in this plan include 11,200 acres of conservation measures, 400 acres of critical area stabilization, one multiple purpose structure, four floodwater retarding structures and approximately seven miles of channel improvement. The works of improvement proposed by this plan will reduce average annual damages by about 70 percent.

The Laurens Soil and Water Conservation District will be responsible for all land treatment. Plantings on critical areas will be done by landowners or by contract. Accelerated technical assistance to speed

land treatment will be furnished with PL-566 funds.

Estimated project costs of \$1,330,320 will be divided between PL-566 and other funds as follows:

	<u>PL-566 Funds</u>	<u>Other Funds</u>	<u>Total Funds</u>
Land treatment (including critical areas and accelerated technical assistance)	\$110,550	\$363,750	\$ 474,300
Structural measures (excluding cost allocated to municipal water)	613,440	103,870	717,310
Cost allocated to municipal water	-	41,660	41,660
<u>Project Administration</u>	<u>89,640</u>	<u>7,410</u>	<u>97,050</u>
Total Cost	\$813,630	\$516,690	\$1,330,320

Project measures will be installed during a five year period. Landowners will maintain the land treatment measures according to their conservation plans. The Upper Laurens County Water District will operate and maintain Structure 1. Funds for this purpose estimated to cost \$380 annually, will be obtained through the sale of water and tax revenues. The Beaverdam-Warrior Creeks Watershed Conservation District will operate and maintain all other structural measures. Funds for this operation and maintenance, estimated to cost \$2,820 annually, will be obtained from the Laurens Soil and Water Conservation District funds or by a tax levy on real property in the watershed.

There are 50 landowners along the flood plain who will receive direct benefits from the flood reduction. Residents of the watershed and surrounding area will benefit directly and indirectly from the project.

The average annual benefits from the planned structural measures are \$77,870, and the average annual cost is \$45,290, resulting in a 1.7 to 1.0 benefit-cost ratio.

DESCRIPTION OF THE WATERSHED

Physical Data

Beaverdam-Warrior Creeks Watershed, a part of the Santee River Basin, is located in north-central Laurens County. The watershed is approximately midway between Columbia and Greenville and lies partially between Interstate 26 and U. S. Highway 276. The city of Laurens is about four miles south of the watershed. The town of Gray Court, and the communities of Barksdale, Lanford, Owings, and Ora are contained or partially contained within the watershed boundary. The town of Enoree lies just outside the northern border of the watershed on U. S. Highway 221. Beaverdam and Warrior Creeks flow easterly to their confluence with the Enoree River. The watershed, approximately 12 miles long, and 5 miles wide, comprises 35,600 acres.

Buckhead Creek, a small tributary located between Beaverdam and Warrior Creeks, is a separate hydrological unit and outlets into the Enoree River. It was not included in the application for assistance nor was it included in the formal Watershed Conservation District. It was excluded because there is little or no flood plain that could be benefited by works of improvement.

The upland areas are broad and moderately sloping. Narrow steep ridges occur adjacent to Warrior and Beaverdam Creeks in the lower reaches. Gorge areas possibly associated with zones of failure in the underlying rock are frequent throughout the watershed. The principal soils are Cecil, Appling, Davidson, and Durham. The major rock type underlying the watershed is granite. Biotite pegmatites are numerous in the ridge areas adjacent to Beaverdam and Warrior Creeks. Some of the biotite pegmatites are presently being open pit mined for vermiculite, a weathering product of biotite. There are four open pit mines, ranging in size from 10 to 30 acres. The principal uses of vermiculite are for plaster and concrete aggregate and loose fill insulation. W. R. Grace and Company, Zonolite Division, operates a processing plant above U. S. Highway 221 on Warrior Creek. The settling ponds for the processing plant cover approximately 27 acres. An additional open pit, mined for gravel and rock, above County Road 101 and south of U. S. Highway 276, has been abandoned.

The town of Gray Court's water system consists of 5 wells, an elevated storage tank, and water mains and appurtenances. The combined pumping capacity of the wells is 208,800 gallons per day. The elevated tank has a storage capacity of 60,000 gallons. The residents of Barksdale, Owings, and Lanford obtain water from wells. W. R. Grace and Company, Zonolite Division, obtains its main supply of water from a 30 acre lake located on a tributary of Warrior Creek. During droughts additional water can be obtained from their reservoir on Buckhead Creek.

The washing and processing of vermiculite at the plant requires about 3 million gallons of recycled water a day. Water for agricultural purposes and for on-farm residents is obtained primarily from wells, streams and ponds.

The climate is mild and moist. The average annual precipitation is 49.0 inches. Seasonal distribution of precipitation is fairly uniform. The mean annual temperature is 61 degrees Fahrenheit. The mean temperature for January - 45 degrees and July - 79 degrees. The average length of the growing season is 219 days.

Forests cover 19,220 acres of the watershed. Overgrazing, over-cutting of timber, heavy burning, and heavy cultivation of land which has now returned to forest, have produced a poor hydrologic condition of the forest land. Only 3 percent is classed good, 33 percent fair, 39 percent poor, and 25 percent very poor. This can be improved by better management and protection.

Economic Data

The economy of the watershed is based on agriculture, mining, manufacturing and supporting enterprises. Approximately 40 percent of the income derived within the watershed is from farming. Employment in mining operations in the watershed provides a substantial portion of the remaining income.

Principal farm enterprises are livestock production, cotton, soybeans, small grain, and corn. In recent years livestock and soybean production has been increasing while cotton and small grain production has been decreasing. Corn production has decreased, but it appears that corn production for on-farm use as silage and feed grain will increase as livestock production increases.

The present land use is as follows:

<u>Land Use</u>	<u>Acres</u>	<u>Percent</u>
Cropland	6,655	19
Grassland	8,300	23
Woodland	19,220	54
Other Land	<u>1,425</u>	<u>4</u>
TOTAL	35,600	100

All of the watershed is in private ownership. Land values vary from \$75 to \$1,500 per acre, depending on improvements, location, and soil capabilities. The average value is about \$250 per acre. Flood plain land is valued at a minimum of \$200 per acre.

The average size of farms increased approximately 34 percent and

the per acre value of land and buildings increased approximately five percent from 1959 to 1964, according to the United States Census of Agriculture for these years. This trend of increased farm size and increased value per acre has continued over the past five years.

There are approximately 90 farms in the watershed having an average size of 200 acres. The average value per farm is \$45,000 including fixed improvements. Practically all of the farms are family units. There is very little use of full time labor by farmers in the watershed, but some hire seasonal labor and custom work. As shown in the following table, in 1964, 72 percent of the farmers produced and sold farm products valued at less than \$2,500. This would give the farmer a net income of from \$1,000 to \$1,500 annually. The estimated value of products sold per farm, number of farms, and percent in each range are as follows:

<u>Value of Products Sold per Farm</u>	<u>No. of Farms</u>	<u>Percent of Farms</u>
Less than \$2,500	65	72
\$2,500 - \$ 4,999	11	12
\$5,000 - \$ 9,999	5	6
\$10,000 - \$19,999	4	4
\$20,000 and over	5	6
TOTAL	90	100

The watershed has excellent transportation facilities. The Seaboard Coastline Railroad serves the area. U. S. Highways 276 and 221 cross the watershed and Interstate 26 is located approximately 2 miles east of the watershed. Numerous state highways and farm-to-market roads also serve the area.

Laurens County is in the Upper Savannah Economic Development District, which was set up July 1, 1968 under the Economic Development Act of 1965. This Act provides that areas and regions of substantial and persistent unemployment and underemployment could be designated as such and be eligible for Federal financial assistance in cooperation with the states. There is considerable potential for promoting community development in this watershed through improved land use, increased farm income, and improved water supply, which will attract industry and create job opportunities for the underemployed and unemployed.

Ninety percent of the woodlands, or 17,220 acres, are in upland types. These upland types are pine, 45 percent; pine-hardwoods, 8 percent; hardwood-pine, 24 percent; and hardwood, 23 percent. The principal species of the upland are loblolly pine, shortleaf pine, Virginia pine, red cedar, red oak, white oak, yellow poplar, sweetgum, hickory, and dogwood. Other species include maple, sycamore, persimmon, and black cherry.

Woods in the flood plain above and below structures constitute 2,000 acres or 10 percent of the total forest lands. Principal species in the flood plain are red maple, yellow poplar, ash, sycamore, red gum, cottonwood, black gum, water oak, and willow oak.

The total stocking on the area is 97 percent well stocked, and 83 percent stocked with merchantable species.

The sawtimber volume averages 1,018 board feet per acre of pine, and 682 board feet per acre of hardwood. There is only a small amount of hardwood in the upland. The pulpwood averages 275 cubic feet per acre of pine and 214 cubic feet per acre of hardwood.

The South Carolina State Commission of Forestry is providing technical forestry assistance, forest fire protection and suppression, distribution of planting stock and forest pest control assistance to private landowners. This is being accomplished in cooperation with the U. S. Forest Service, through the various Federal-State cooperative forestry programs.

There are no lands administered by the U. S. Forest Service in the watershed. Most of the forest land is in small private ownership, with only 6 percent in industrial holdings. Given protection and proper management, the forest stands will contribute to the future overall economy of the watershed area.

Land Treatment Data

The most severely eroding areas in the watershed are open pit mines, clean tilled fields, dirt roads, and road cuts. The soils in these areas are in Capability Classes IIe, IIIe, and IVe. Trends in land use indicate that some of the upland now in row crops, small grain, and woods, will be changed to grassland.

Due to extreme flooding, much of the flood plain pasture and grassland cannot be properly managed and some of the flood plain land has recently reverted to low producing hardwood and brush. With protection from flooding, and resulting damages, fertile land will be restored to high yielding pasture. Flood plain soils are mostly IIIw, with areas of Classes IIw and IVw.

A major goal of the Laurens Soil and Water Conservation District is a complete land treatment program. About 60 percent of the needed land treatment practices have been applied and are valued at \$641,410 (Table 1A). The District has assisted the owners of 29,000 acres, or 82 percent of the watershed with complete soil and water conservation plans.

Fish and Wildlife Resource Data

The watershed stream fishery is not of significant value. Catfish and sunfish are taken at the mouths of Beaverdam and Warrior Creeks. Suckers, minnows, and bullheads are the predominant fish in these small turbid streams.

The hardwood timber along the bottoms is the best wildlife habitat. Hunting is mostly for small game and waterfowl. Deer and turkey populations are increasing near the mouths of Beaverdam and Warrior Creeks.

WATERSHED PROBLEMS

Floodwater Damage

One of the major problems is floodwater damage on 1,613 acres. Flooding occurs one to three times per year. Approximately 37 percent of the floods occur during the growing season (April through September). Farmers have been forced to move row crops from the flood plain to the uplands where yields are lower and production costs are higher. Average annual floodwater damage to crops and pasture is about \$8,840. Other agricultural damage is \$1,740 annually.

Non-agricultural damage results from scouring of road embankments and surfaces, erosion of fills adjacent to bridge abutments, increased operation and maintenance cost of road ditches, bridges, and culverts due to accumulation of sediment and debris. This damage amounts to an estimated \$7,250 annually.

Sediment Damage

Clearing and snagging by the landowners has considerably altered and improved sections of the channel system of Warrior Creek. The flood plain of Warrior reflects a past history of heavy sediment deposition. Above U. S. Highway 221 sediment damages are decreasing. Continued flooding of these damaged areas retards the rate of recovery. Diking caused by overbank deposition continues to impede drainage and as a result swamping damages are increasing.

Clearing and snagging by landowners in the area immediately below U. S. Highway 221 has failed to alleviate swamping. Deposition of fine grained material on the flood plain has produced a water trap. Swamping is increasing in this area and on down as far as the gorge on the lower end of Warrior Creek. Present localized sediment damages are occurring at a rate equivalent to the recovery of past sediment damages.

Heavy deposition of fine grained sediment and diking caused by

overbank deposition between Structure 1 and the confluence of Beaverdam Creek and Wallace Branch impedes drainage of the flood plain resulting in expanding swamps. In the uppermost parts of this reach, channels are practically non-existent, water flowing much in the manner of a braided stream. In the remainder of this reach channels are elevated above the flood plain, having been trapped by their own overbank deposits. Channels are elevated above the flood plain and sediment and swamping damages are increasing from Wallace Branch to midway between S. C. Highways 399 and 97. A fair channel system has begun to develop in the area immediately above S. C. Highway 97 and most swamping and sediment damages are decreasing. Some clearing and snagging work has been done in this area.

A scenic gorge area is located approximately one mile upstream from the confluence of Beaverdam Creek and the Enoree River. The discharge from the gorge area maintains a fair channel to near its confluence with the Enoree River where heavy deposition of sediment has produced sand bars and a delta. Between S. C. Highway 97 and the Enoree River severe sediment damages are occurring at a rate equivalent to the recovery of past sediment damages.

Erosion Damage

Intensive cultivation practices around the turn of the century caused loss of most of the topsoil in the watershed. The trend in the past decade has been toward less cultivated land and more pasture and woodlands. Nonetheless, a significant percentage of the upland remains in cultivation. Present upland erosion is moderate to severe. Approximately 94 percent of all upland erosion occurs as sheet erosion on cultivated land, pasture and woodland. The remaining six percent of upland erosion occurs on dirt roads, road cuts, and areas of open pit mining. Streambank, flood plain, and gully erosion are minor in this watershed.

The average annual rates of erosion in tons per acre by types are: cultivated land - 12, pasture - 2, woods - 0.7, galled areas (woods and pastures) - 30, borrow areas - 40, road cuts - 60, dirt roads - 100, and open pit mines - 150. Sheet erosion from cultivated land, pasture and woodland is the source of 84 percent of all downstream sediment damages. Soil loss from dirt roads, road cuts, borrow areas, and open pit mines are the source of the remaining 16 percent of downstream sediment damages. With the exception of the open pit mines, critical areas are distributed throughout the watershed. Most of the open pit mines are located along drainage divides in the lower area of the watershed.

Problems Relating to Water Management

Most of the existing channels have adequate capacity to meet the

sponsors' objectives after proposed floodwater retarding structures are installed. Some channel improvement will be necessary on the main stems of both Beaverdam and Warrior Creeks. Drainage is not considered a problem.

The population and industrial growth of the area in and around the watershed has created a need for municipal and industrial water. The town of Gray Court and the surrounding areas obtain their water from wells. This limited water supply has virtually stifled the growth of the area. The town of Gray Court is approximately nine miles south of the highly industrialized Greenville area, but because of the lack of an adequate water supply, it is unable to attract industry. The Upper Laurens County Water District has been formed to supply water to the town and the surrounding area. The Water District has no present source of water.

The water quality in all streams is satisfactory for the intended uses. Beaverdam Creek, which is presently unclassified, will be properly classified before Structure 1 is installed. A public hearing for this purpose was held by the South Carolina Pollution Control Authority on May 28, 1969. No opposition to classification was made at the hearing. The South Carolina Pollution Control Authority will enforce adequate treatment to assure that proper quality is maintained.

The watershed stream fishery is not of significant value. Small game and waterfowl are the primary wildlife species. Deer and turkey populations are increasing near the mouths of Beaverdam and Warrior Creeks.

PROJECTS OF OTHER AGENCIES

There are no known projects proposed by other agencies which will affect the works of improvement in this plan.

PROJECT FORMULATION

Project objectives are: (1) to apply needed land treatment measures and desirable land use adjustments; (2) to provide a minimum of 60 percent reduction of the average annual flood damages in the benefited area; and (3) to store approximately 255 acre feet of municipal water for the Upper Laurens County Water District.

Frequent floods carrying substantial volumes of sediment practically prohibit the use of sections of the flood plain for row crops and improved pasture. Sediment deposits and the accumulation of debris have reduced the capacity of the stream channels. Some areas have such shallow channels that they flood frequently. Flood prevention and

watershed protection are needed to bring about proper land use and adjustments.

Rainfall, runoff characteristics, condition of channels, present land use, and flood plain conditions were studied to determine the most feasible combination of structural measures to meet the sponsors' objectives. These objectives could best be met with a combination of land treatment, floodwater retarding structures, and channel improvement.

Industry has been attracted to adjacent areas by a plentiful water supply, excellent highways, railroads, natural gas systems, plant sites, and people. The Upper Laurens County Water District area, including the town of Gray Court, needs additional water to attract industry and to meet present and future needs. The planned municipal water storage will insure a supply of approximately two million gallons per day for present and future use.

The land treatment program was developed from a field survey of the watershed and is based on additional needs other than those supplied by the going programs. The land treatment needs are adjusted for expected landowner participation and are limited by the length of the planned installation period. The average allowable soil loss per year is approximately four tons per acre.

The proposed works of improvement will not materially increase the fire hazard or risk to forest land. The state goal for the annual fire loss index is 0.25 percent, while the present watershed protection goal is 0.20 percent. The average annual fire loss index in the watershed for the period 1963 through 1967 was 0.014 percent. The present fire control program meets the watershed protection standards, and no intensification is included in the plan.

The watershed stream fishery is not of significant value. The five reservoirs will provide additional fishing opportunities in the watershed.

WORKS OF IMPROVEMENT TO BE INSTALLED

Land Treatment Measures

Land treatment measures will be applied on 2,300 acres of cropland for soil improvement and erosion control. These measures include conservation cropping systems, grassed waterways, terraces, crop residue management, and field borders. Work Unit Technical Guides outline alternatives.

Grass will be planted on 1,800 acres. About 3,000 acres of grassland will be managed to reduce erosion and improve production.

To improve wildlife habitat, 300 acres of land will be planted to lespedeza bicolor and other food and cover crops.

Access roads, recreation area stabilization and improvement, land grading and shaping, with trails and walkways as needed, will be installed on 150 acres of recreation land.

A total of 400 acres of critically eroding areas will be treated. Planned treatments on 300 acres will include shaping, mulching, and planting grasses and legumes. There are 100 acres of open, critically eroding land to be stabilized by planting trees. Loblolly pine will be the primary species used. Site preparation will be done where necessary. Fencing will be included to protect pine seedlings where needed.

Reforestation of appropriate open land and understocked stands is necessary to adjust land use within its capability, and to reduce runoff and erosion by developing a protective cover and an absorbent forest floor of a spongy humus layer, under a protective layer of litter. The South Carolina State Commission of Forestry will continue the going Cooperative Forest Fire Control Program.

Soil surveys within the watershed area are complete.

Structural Measures

Structural measures consist of four single purpose structures for flood prevention, one multiple purpose structure for flood prevention and the storage of municipal water, and approximately seven miles of stream channel improvement for flood prevention. All planned structural measures will meet the requirements of local and state health laws. The planned location of structural measures is shown on the Project Map on Page 41. Design data are shown in Tables 3 and 3a.

The total drainage area above structures on Beaverdam Creek is 7,146 acres, or 58 percent of the Beaverdam Creek watershed area. The total drainage area above structures on Warrior Creek is 9,604 acres, or 41 percent of the Warrior Creek watershed area. The total drainage area above all structures is 16,750 acres, or 47 percent of the watershed area. Structure 1 will store 255 acre feet of municipal water for the Upper Laurens County Water District.

Municipal water will be removed from the reservoir of Structure 1 through a separate reinforced concrete intake riser and a pipe with anti-seep collars placed through the dam. The Water District plans to extend this pipeline to their proposed water filter plant facilities.

All five structures will consist of earthfill embankments on yielding foundations, reinforced concrete principal spillways, and vegetated emergency spillways. Each principal spillway will have a

reinforced concrete inlet, reinforced concrete pipe with anti-seep collars, and will outlet into an excavated plunge basin. Vertical relief wells will be added to the normal foundation drain of Structure 1 to relieve uplift pressures in the event that a detailed foundation investigation proves them to be excessive. The emergency spillway for Structure 1 will have a one percent chance of operation in any year. The emergency spillway for Structure 5 will have a 1.3 percent chance of operation in any year. The emergency spillway for Structures 2, 4, and 33 will have a 2 percent chance of operation in any year.

All structures are designed for an effective life of 100 years. The crest elevation of the principal spillways for Structures 2, 4, 5, and 33 will be the 50-year sediment accumulation elevation. The crest elevation of the principal spillway for Structure 1, which has a 100-year sediment pool, will be the maximum elevation of the municipal water pool. The upstream face of this embankment will be riprapped in the area subject to drawdown and wave action.

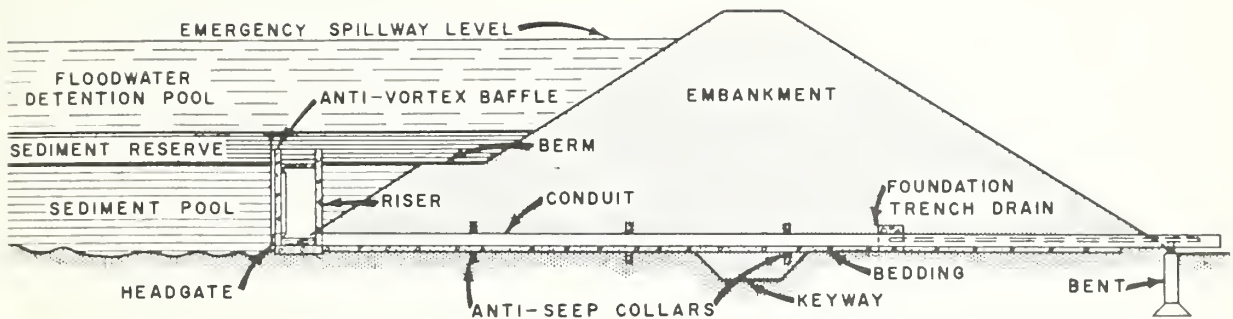
A substantial amount of borrow material will be obtained from the excavated emergency spillways. Other borrow areas are available near the proposed structures. Suitable vegetation will be established on the embankments, emergency spillways, and exposed borrow areas.

The structures will not require changes to fixed improvements other than moving farm fences presently located in the proposed reservoir areas.

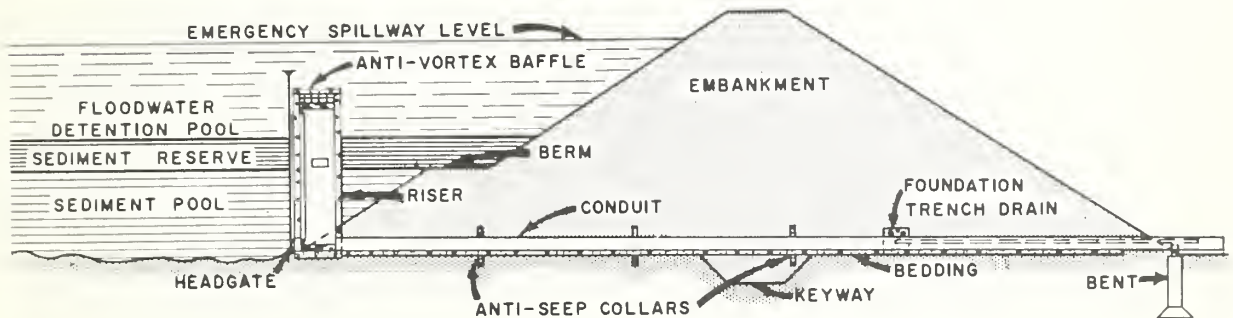
Channel improvement consists of approximately 3.1 miles of channel enlargement on Beaverdam Creek and approximately 3.9 miles of channel enlargement on Warrior Creek.

The improved channel will generally follow the same course as the existing channel, except where corrections are needed to prevent erosion. The outer banks of curves will be disturbed as little as possible. Spoil will be placed on either or both sides of the channel and shaped to facilitate maintenance. Where necessary, side drainage will enter the channel by side inlet pipes or ditches. Rock fords or culverts may be necessary to provide access for maintenance. The width and depth of channels were selected to provide the desired flood protection. They were proportioned to blend into the existing channels. The design discharge shown in Table 3A is the discharge which the channel will contain before damage begins.

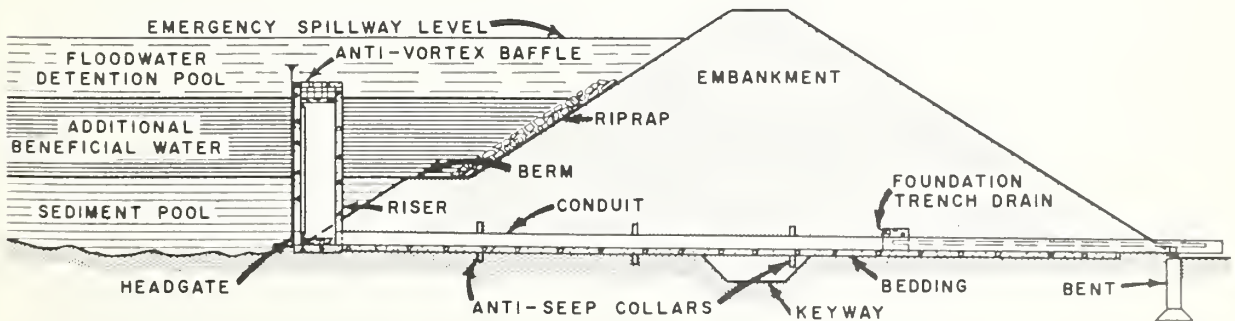
Channel construction work will be scheduled for completion at the time of year to provide a full growing season immediately following construction. The soil, site, moisture, climate, and fertility relationship in this watershed is very favorable for quick vegetative growth. Experience in previously constructed channels has shown that natural vegetation will rapidly cover channel banks, normally in one growing



TYPICAL SECTION OF FLOODWATER RETARDING STRUCTURE WITH SINGLE STAGE RISER



TYPICAL SECTION OF FLOODWATER RETARDING STRUCTURE WITH TWO STAGE RISER



TYPICAL SECTION OF MULTIPLE PURPOSE STRUCTURE WITH SINGLE STAGE RISER

season.

An inspection will be made of the channel improvement work after the first full growing season to determine the adequacy of native vegetative cover. Bare areas found to be contributing sediment will be stabilized with suitable vegetation as a project measure. Based upon a recent study of previously improved channels in the Piedmont Area of South Carolina, all planned channel improvement will be stable with insignificant amounts of erosion.

EXPLANATION OF INSTALLATION COSTS

Land Treatment

Land treatment measures to be applied during the five year project installation period are estimated to cost \$474,300. Of this total, \$110,550 will be paid by PL-566 funds and \$363,750 will be provided by other funds.

The PL-566 funds include \$39,600 for accelerated technical assistance by the Soil Conservation Service and \$27,400 for accelerated technical assistance by the U. S. Forest Service. In addition, PL-566 funds will provide \$4,800 cost sharing for planting trees on critical areas by the U. S. Forest Service, and \$38,750 cost sharing for planting grasses and/or legumes on other critical areas by the Soil Conservation Service.

Other funds include \$20,000 for technical assistance provided under the going program of the Soil Conservation Service; \$5,700 for accelerated technical assistance by the U. S. Forest Service through the South Carolina State Commission of Forestry; \$400 for additional services by the going Cooperative Forest Management Program, and \$3,800 under the going Cooperative Forest Fire Control Program. The remainder of other funds will be borne by individual landowners and operators, utilizing the cost sharing assistance available through the Agricultural Conservation Program. These costs include labor, machinery, and materials necessary for the installation of the land treatment measures.

Structural Measures

Total structural installation cost is \$856,020 and consists of construction, engineering services, project administration, and land rights.

The construction cost of each structural measure is the estimated cost of all material and labor necessary for construction. These costs, estimated to be \$588,700, were determined for each structure and each channel reach by estimating the quantities required for construction

and applying unit costs based on previously constructed projects. Included in the construction cost is a 12 to 14 percent contingency allowance to cover unforeseen items that may be encountered during construction.

Engineering services are estimated to be \$63,200 and consist of the cost of design surveys, geological investigations, design, and preparation of plans and specifications for the structural measures.

Project administration costs estimated to be \$97,050 consist of costs associated with the installation of structural measures, including the cost of contract administration, review of engineering plans prepared by others, government representatives, construction surveys, and necessary inspection during construction.

Land rights costs include all land values and expenditures made in acquiring easements and rights-of-way, and all costs associated with altering roads, gas and water lines, telephone cables, power lines, or other fixed improvements affected by the structural measures. No changes to fixed improvements, other than moving farm fences, were found during planning; however, any alterations which are necessary during construction will be considered as land rights costs. These total costs are estimated to be \$107,070.

The cost of necessary permeability tests to investigate the stability of Structure 1 was included as a joint cost. Total joint costs for the installation of Structure 1 amount to \$217,730. These costs were allocated by the Use of Facilities Method. Using this method, 9.1 percent (\$19,810) was allocated to municipal storage and the remaining 90.9 percent (\$197,920) to flood prevention. Specific costs (\$21,850) for a water intake riser with a pipe conduit through the dam were allocated entirely to municipal storage. Project administration costs were not allocated, as they were not considered applicable to individual purposes served by the project. The local sponsors and the Service will each bear their respective project administration costs which they encounter. The local sponsors have requested that the Service administer the contracts for all the structural measures.

Estimated installation cost of the flood prevention structures and channel improvement amounts to \$519,390, all of which was allocated to flood prevention.

Following the existing procedure of cost sharing, the total PL-566 cost for structural measures is \$613,440 and other cost amounts to \$145,530. (Table 2A.) Adding project administration costs, the PL-566 cost is \$703,080 and other cost is \$152,940. (Table 2.)

Schedule of Obligations

Estimated expenditures by years are as follows:

Project Year	PL-566 Funds		Other Funds	
	Structural Measures	Land Treatment	Structural Measures	Land Treatment
First	190,150	27,640	77,070	90,940
Second	129,250	22,110	16,470	72,750
Third	144,070	22,110	27,500	72,750
Fourth	175,170	22,110	20,300	72,750
Fifth	64,440	16,580	11,600	54,560
TOTAL	703,080	110,550	152,940	363,750

This schedule may be changed as necessary, depending on land treatment accomplishments, availability of funds, and the local organization's ability to acquire land rights.

EFFECTS OF WORKS OF IMPROVEMENT

The average annual acres flooded (including repetitive flooding) in the benefited area will be reduced from 2,116 to 825 after installation of the proposed land treatment and structural measures. In the benefited area, the works of improvement will reduce flooding as shown in the following table:

Storm Frequency (years)	Area Flooded Without Project (acres)	Area Flooded With Project (acres)
0.25	77	0
1	916	363
2	1,217	668
3	1,327	837
10	1,453	1,086
100	1,613	1,323

An overall 70 percent reduction in flood damages will allow farmers to plant an estimated 266 acres of row crops, which will be utilized locally, and establish and maintain about 796 acres of high producing pasture on the flood plain.

Other planned beneficial land use adjustments include converting 1,800 acres of land to improved pasture and 400 acres of critical areas to trees, grasses, and legumes.

Approximately 50 family farms covering 1,613 acres of flood plain will benefit from the flood reduction provided by structural measures. Most of these farms are low income units. Land use adjustments made possible by the project will enable these farmers to increase their income.

The average damage reduction from overbank deposition and swamping for the life of the project is 64 percent and consists of 9 percent due to land treatment, 53 percent due to structures, and 2 percent due to channel improvement. Land subject to overbank deposition and swamping will require from 1 to 5 years to recover, with more time required on some small areas.

The sponsors plan to make the pool areas and necessary adjacent land of the structures available to the general public or organized groups for incidental recreational activities, such as boating, fishing, and picnicking.

Project installation will create additional employment opportunities for unemployed or underemployed residents. Operation and maintenance of the project measures will also provide some employment.

Secondary benefits accrue as a result of increased income from transporting, processing, and marketing of goods and services which produce the primary benefits, and from supplying additional materials to farmers.

Improved land use, increased farm income, and increased recreational facilities will enhance the development of the community.

Channel excavation will reduce the quality of the stream fishery, but this loss will be offset by the additional fishing opportunities provided at the five structure sites. These sites will provide a total surface area of 204 acres.

PROJECT BENEFITS

The estimated average annual monetary damage due to floodwater, sediment, erosion, and indirect damages within the watershed will be reduced from \$36,550 to \$7,670 (Table 5) by the proposed project. Total annual flood damage reduction benefits include \$13,590, floodwater; \$13,240, sediment; and \$2,050, indirect for a total of \$28,880. Flood-water damage reduction benefits include \$6,260 from restoration of former productivity. Flood damage reduction benefits include \$1,670 from land treatment and \$27,210 from structural measures annually (Table 6). More intensive land use benefits are estimated to be \$11,660 annually.

The permanent pools of the structures will provide incidental recreation benefits estimated at \$10,470 annually. These benefits are based on a value of \$1.00 per visitor day and 13,215 visitor days annually, discounted to allow for the accumulation of sediment and the possible limited use of the municipal structure. Before these pools are made available to the general public or organized groups, sanitary facilities will be installed as required by the South Carolina State Board of Health. Appropriate associated costs for installing, operating, and maintaining these sanitary facilities were deducted from gross benefits. These facilities are not project measures, but will be installed as needed by landowners. The permanent pools of the structures will also increase the value of the land surrounding them. It is estimated that 50 lots will be created. The average annual benefits from enhanced land values are estimated to be \$3,200. This results in total incidental benefits of \$13,670 annually (Table 6).

The value of local secondary benefits is \$11,440 annually (Table 6). These benefits accrue as a result of increased business activity and improved economic condition, which are induced by and stem from the installation of project measures. Secondary benefits from a national viewpoint were not considered in the economic evaluation of this project.

Since Laurens County is in the Upper Savannah Economic Development District, which was officially formed July 1, 1968, under authority of the Economic Development Act of 1965 and designated as being an area of substantial and persistent unemployment and underemployment, redevelopment benefits were calculated and used in project justification. These benefits accrue from added employment during project construction, operation, and maintenance. Average annual redevelopment benefits are estimated to be \$6,390.

The proposed forest land treatment measures will improve the hydrologic condition and productivity of the forest land. This will reduce sediment and retard storm runoff. Good management and continued fire protection will increase the productivity of forest lands.

COMPARISON OF BENEFITS AND COSTS

The average annual cost of the structural measures, including operation and maintenance, is estimated to be \$45,290. These measures are expected to produce average annual benefits of \$77,870. The ratio of average annual benefits to average annual costs is 1.7 to 1.0. This includes local secondary benefits of \$11,440 annually (Table 6). The benefit-cost ratio without local secondary benefits is 1.5 to 1.0.

PROJECT INSTALLATION

The planned installation period for the project is five years. Land treatment measures will be applied during this time by the landowners. The Laurens Soil and Water Conservation District, with technical assistance from the Soil Conservation Service, will help landowners plan and apply the land treatment measures. This assistance will be accelerated to insure the application of planned measures within the five year period.

Owners of forest land will be encouraged to apply and maintain the best forestry measures. The U. S. Forest Service, through the South Carolina State Commission of Forestry, will provide technical forestry assistance for forest land treatment measures. A forester trained in watershed management will be assigned to the project to assist and guide the landowners in the installation of planned forestry measures.

The South Carolina State Commission of Forestry, in cooperation with the U. S. Forest Service, will assist the landowners with tree planting on 100 acres of critical areas. Site preparation and tree planting on critical areas will be paid for by PL-566 funds. The landowners and operators will buy the trees, furnish mulch material, and construct or relocate fences where needed to protect the seedlings.

Grasses and legumes will be applied on critical areas in open fields. The landowners and operators will apply lime, fertilizer, and mulch, prepare seedbeds, plant seed or plants, and relocate fences where necessary. The required seed, plants, mulch, lime, and fertilizers, will be paid by PL-566 funds.

Vegetation will be established on severely eroding gullies. The sponsors will be responsible for sloping banks, moving fences, and constructing diversions, and gully plugs as necessary. Costs of materials and planting of vegetation on these critical areas will be paid by PL-566 funds.

All critical area plantings will be done through project agreements and district cooperative agreements with the Laurens Soil and Water Conservation District.

The Beaverdam-Warrior Creeks Watershed Conservation District will be responsible for obtaining land rights required for the installation of all structures and channel improvement. The Upper Laurens County Water District and the town of Gray Court will assist in obtaining land rights for Structure 1. The sponsors have the necessary legal authority to acquire these land rights. All land rights will be obtained during the first three years of the project installation period.

The Service will provide the engineering services for the construction of all channel improvement and structures, except Structure 1. The Service will negotiate an A&E contract with a private engineering firm for the engineering services for Structure 1. The cost of these services for Structure 1 will be shared 9.1 percent by the Upper Laurens County Water District and 90.9 percent PL-566.

The sponsors have requested that the Service administer the contracts for the construction of structures and channel improvement, and treatment of critical areas. The signing of this Watershed Work Plan Agreement will constitute approval of this request. The Upper Laurens County Water District will be the sponsor responsible for dealing with the Service during the construction of Structure 1. The Beaverdam-Warrior Creeks Watershed Conservation District will deal with the Service during the construction of all other structural measures and the treatment of critical areas.

The structural measures are grouped in construction units as shown in Table 7. Each of these units may be constructed as land rights are obtained and funds available.

Planned installation schedule for the structural measures is as follows:

<u>Project Year</u>	<u>Structural Measure</u>
First	Structure 1
Second	Structure 2 and channel improvement on Beaverdam Creek
Third	Structure 5
Fourth	Structures 4 and 33
Fifth	Channel improvement on Warrior Creek

This schedule may be changed as necessary, except that channel improvement on Beaverdam and Warrior Creeks may not be begun until construction of upstream structures is assured.

FINANCING PROJECT INSTALLATION

Federal assistance for carrying out the works of improvement described in this Work Plan will be provided under the authority of the Watershed Protection and Flood Prevention Act (PL-566), as amended. Financial and other assistance to be furnished by the Service in carrying out the plan is contingent upon the availability of funds for this purpose.

The following conditions must be met prior to the Service providing financial assistance for the construction of any planned structural

measure: (1) the Laurens Soil and Water Conservation District will obtain agreements with landowners to carry out soil and water conservation plans on at least 50 percent of the area above each structure, (2) adequate treatment measures must be applied on at least 75 percent of those sediment source areas, which, if uncontrolled, would materially increase the cost of construction, operation, or maintenance of the structural measure, (3) all land rights must be obtained for all structural measures within a construction unit, (4) specific operation and maintenance agreements must be executed, and (5) the Sponsoring Local Organizations must be prepared to discharge their responsibilities.

The cost of applying land treatment measures on private land will be borne by the landowners and operators. The Agricultural Conservation Program and other going programs will provide cost sharing and technical assistance for some land treatment measures.

The cost of establishing 400 acres of critical area plantings, except the PL-566 portion, will be borne by individual landowners. The landowner's share will be done in accordance with the division of work as set forth in the Watershed Work Plan Agreement.

Landowners and operators will provide the other than PL-566 share of the costs of the forest land treatment measures to be applied. This will be done under the division of work as described in the Watershed Work Plan Agreement. The Agricultural Stabilization and Conservation Service is expected to cost share with qualified landowners in the installation of these measures.

It is anticipated that the necessary land rights will be donated for all channel work and structures. Necessary funds required for the purchase of any land not donated will be obtained from a tax levy on real property within the watershed or from Water District funds.

The provisions of Section 8, PL-566 as amended, will be utilized by the Upper Laurens County Water District to finance costs allocated to them for Structure 1. The Water District has filed Standard Form 101 with the State Director of the Farmers Home Administration requesting a loan of \$64,000. The Water District will obtain adequate funds for repaying this loan through the sale of water and tax revenues.

PROVISIONS FOR OPERATION AND MAINTENANCE

Land treatment measures will be maintained by the owners and operators of the land on which they are installed, in cooperation with the Laurens Soil and Water Conservation District. The South Carolina State Commission of Forestry, in cooperation with the U. S. Forest Service, will furnish the technical assistance necessary for forest land

treatment measures under the going Cooperative Forest Management Program. The South Carolina State Commission of Forestry will also continue to furnish fire protection under the going Cooperative Forest Fire Control Program.

Specific maintenance agreements between the Service and the sponsors will be executed prior to issuing bid invitations for construction of each structural measure. The sponsors will operate and maintain all structural measures. This will include mowing, fertilizing, and controlling the vegetation, replacement of side inlet pipes for the channels, as well as the repair of damage to the emergency spillways, embankments, and stream channels.

The Upper Laurens County Water District will operate and maintain Structure 1. Funds for this purpose, estimated at \$380 annually, will be obtained through the sale of water and tax revenues.

The Beaverdam-Warrior Creeks Watershed Conservation District will operate and maintain all other structural measures. Funds for this operation and maintenance, estimated to cost \$2,820 annually, will be obtained from the Laurens Soil and Water Conservation District or by a tax levy on real property in the watershed.

For three years following installation of each structural measure, the Service and the sponsors will make joint inspections annually, after unusually severe floods or after the occurrence of any other unusual condition that might adversely affect the structural measures. Inspections after the third year will be made annually by the sponsors. One copy of their report will be sent to the Service representative and one copy filed by the sponsors and made available for authorized inspection.

TABLE 1 - ESTIMATED PROJECT INSTALLATION COST

Beaverdam-Warrior Creeks Watershed, South Carolina

Installation Cost Item	Unit	Number	Estimated Cost (Dollars) 1/		Total
			PL-566 Funds	Other	
<u>LAND TREATMENT</u>					
Soil Conservation Service					
Cropland	Ac.	2,300	-	23,000	23,000
Grassland	Ac.	4,800	-	233,000	233,000
Wildlife Land	Ac.	300	-	600	600
Miscellaneous Land (Rec.)	Ac.	150	-	17,500	17,500
Critical Area Stabilization	Ac.	300	38,750	38,750	77,500
Technical Assistance			39,600	20,000	59,600
SCS Subtotal			78,350	332,850	411,200
Forest Service					
Critical Area Stabilization	Ac.	100	4,800	1,900	6,700
Forest Land Treatment	Ac.	3,650	-	19,100	19,100
Cooperative Forest Fire Control Program	Ac.	19,220	-	3,800	3,800
Technical Assistance			27,400	6,100 2/	33,500
FS Subtotal			32,200	30,900	63,100
TOTAL LAND TREATMENT			110,550	363,750	474,300
<u>STRUCTURAL MEASURES</u>					
<u>Construction</u>					
Soil Conservation Service					
Multiple Purpose Str.	No.	1	153,880	36,100	189,980
Floodwater Retarding Strs.	No.	4	320,970	-	320,970
Channel Improvement	L.Ft.	36,960	77,750	-	77,750
Subtotal - Construction			552,600	36,100	588,700
<u>Engineering Services</u>					
Soil Conservation Service			60,840	2,360	63,200
Subtotal - Engineering			60,840	2,360	63,200
<u>Project Administration</u>					
Soil Conservation Service					
Construction Inspection			30,510	1,000	31,510
Other			59,130	6,410	65,540
Subtotal - Administration			89,640	7,410	97,050
<u>Other Costs</u>					
Land Rights			-	107,070	107,070
Subtotal - Other			-	107,070	107,070
TOTAL STRUCTURAL MEASURES			703,080	152,940	856,020
TOTAL PROJECT			813,630	516,690	1,330,320
<u>SUMMARY</u>					
Subtotal SCS			781,430	485,790	1,267,220
Subtotal FS			32,200	30,900	63,100
TOTAL PROJECT			813,630	516,690	1,330,320

1/ Price Base: 1968

2/ Includes \$400 from the going Cooperative Forest Management Program.

May 1969

TABLE 1A - STATUS OF WATERSHED WORKS OF IMPROVEMENT
(at time of Work Plan Preparation)

Beaverdam-Warrior Creeks Watershed, South Carolina

Measures	Unit	Applied To Date	Total Cost (Dollars) 1/
<u>LAND TREATMENT</u>			
Conservation Cropping Systems	Ac.	3,000	3,000
Grassed Waterway or Outlet	Ac.	100	5,000
Terrace, Gradient	Ft.	1,000,000	30,000
Terrace, Parallel	Ft.	30,000	1,500
Drainage Field Ditch	Ft.	15,000	7,050
Drainage Main or Lateral	Ft.	18,000	8,460
Crop Residue Management	Ac.	2,500	2,500
Field Border	Ft.	25,000	750
Diversion	Ft.	7,000	350
Pasture & Hayland Management	Ac.	4,300	86,000
Pasture & Hayland Planting	Ac.	8,500	340,000
Pond	No.	42	42,000
Proper Grazing Use	Ac.	2,800	2,800
Critical Area Planting	Ac.	155	42,000
Access Road	Ft.	20,000	15,000
Recreation Area Stabilization	Ac.	15	3,000
Recreation Land Grading & Shaping	Ac.	5	400
Recreation Area Improvement	Ac.	30	2,250
Recreation Trail & Walkway	Ft.	5,000	500
Wildlife Habitat Management	Ac.	150	750
Forest Land (Private)	Ac.	500	10,000
Forest Land Release	Ac.	100	15,000
Cooperative Forest Fire Control	Ac.	19,220	23,100
TOTAL	XXX	XXX	641,410

1/ Price base 1968.

May 1969

TABLE 2 - ESTIMATED STRUCTURAL COST DISTRIBUTION

Beaverdam-Warrior Creeks Watershed, South Carolina

Item	(Dollars) 1/					Installation Cost - Other Funds			Total Installation Cost
	Con- struction	Engi- neering	P.L. 566	Total P.L. 566	Con- struction	Engi- neering	Land Rights	Total Other	
<u>Multi-purpose Str. 1</u>									
Joint Costs	153,880	12,040		165,920	15,400	1,210	35,200	51,810	217,730
Specific Costs 2/	-	-	-	-	20,700	1,150	-	21,850	21,850
Subtotal	153,880	12,040		165,920	36,100	2,360	35,200	73,660	239,580
<u>FWRS</u>									
2	71,620	8,950		80,570	-	-	8,170	8,170	88,740
4	69,000	8,630		77,630	-	-	10,700	10,700	88,330
5	113,970	12,210		126,180	-	-	26,500	26,500	152,680
33	66,380	8,300		74,680	-	-	8,600	8,600	83,280
Subtotal-Structures	474,850	50,130		524,980	36,100	2,360	89,170	127,630	652,610
<u>Channel Improvement</u>									
Beaverdam Creek	27,760	4,460		32,220	-	-	7,300	7,300	39,520
Warrior Creek	49,990	6,250		56,240	-	-	10,600	10,600	66,840
Subtotal-Channel Imp.	77,750	10,710		88,460	-	-	17,900	17,900	106,360
Subtotal	552,600	60,840		613,440	36,100	2,360	107,070	145,530	758,970
Project									
Administration				89,640				7,410	97,050
GRAND TOTAL	552,600	60,840		703,080	36,100	2,360	107,070	152,940	856,020

1/ Price Base: 1968.

2/ Municipal water intake riser with pipe conduit through dam.

May 1969

TABLE 2A - COST ALLOCATION AND COST SHARING SUMMARY

Beaverdam-Warrior Creeks Watershed, South Carolina

(Dollars) 1/							
Item	COST ALLOCATION			COST SHARING			
	PURPOSE			P.L. 566		OTHER	
	Flood Prevention	Municipal Water	Total	Flood Prevention	Total	Flood Prevention	Municipal Water
Multi-purpose Str. 1							
Joint Costs	197,920	19,810	217,730	165,920	165,920	32,000	19,810
Specific Costs	-	21,850	21,850	-	-	-	21,850
Floodwater Retarding Structures							
2, 4, 5, & 33	413,030	-	413,030	359,060	359,060	53,970	-
Channel Improvement	106,360	-	106,360	88,460	88,460	17,900	-
GRAND TOTAL	717,310	41,660	758,970	613,440	613,440	103,870	41,660
							145,530

1/ Price Base: 1968

May 1969

TABLE 3 - STRUCTURAL DATA
STRUCTURES WITH PLANNED STORAGE CAPACITY

Beaverdam-Warrior Creeks Watershed, South Carolina

Item	Unit	Structure Number					Total
		1	2	4	5	33	
Class of Structure	Sq. Mi.	b	a	b	b	a	
Drainage Area		9.03	2.13	3.13	9.69	2.18	26.16
Curve No. (1-day) (AMC II)		71	73	66	70	68	
Tc	Hrs.	1.85	1.05	0.85	1.90	0.85	
Elevation Top of Dam	Ft.	664.0	658.0	607.0	620.0	599.0	
Elev. Crest Emergency Spillway	Ft.	658.0	656.0	602.0	611.5	597.0	
Elev. Crest High Stage Inlet	Ft.	645.5	650.5	596.0	592.0	592.0	
Elev. Crest Low Stage Inlet	Ft.	-	638.5	587.0	-	583.5	
Maximum Height of Dam	Ft.	35	42	35	41	33	
Volume of Fill	Cu. Yds.	140,100	58,600	60,600	101,900	37,400	398,600
Total Capacity	Ac. Ft.	2,794	699	771	2,450	593	7,307
Sediment Submerged 1st 50 years	Ac. Ft.	260	109	83	180	83	715
Sediment Submerged 2nd 50 years	Ac. Ft.	250	102	85	174	79	690
Sediment Aerated	Ac. Ft.	42	22	17	37	15	133
Municipal Water	Ac. Ft.	255	-	-	-	-	255
Retarding	Ac. Ft.	1,987	466	586	2,059	416	5,514
Between High and Low Stage	Ac. Ft.	-	219	232	-	178	629
Surface Area	Acres	83	15	21	44	19	182
Sediment Pool 1/ Municipal Pool	Acres	105	-	-	-	-	105
Retarding Pool	Acres	226	57	76	201	57	617
Principal Spillway							
Rainfall Volume (areal) (1 day)	In.	7.3	6.9	6.9	7.1	6.9	
Rainfall Volume (areal) (10 day)	In.	12.1	11.9	11.9	12.0	11.9	
Runoff Volume (10 day)	In.	5.55	5.87	4.45	5.32	4.93	
Capacity of Low Stage (Max.)	cfs.	-	22	27	-	22	
Capacity of High Stage (Max.)	cfs	163	115	103	165	106	
Frequency of Operation - Emer. Spillway	% Chance	1	2	2	1.3	2	
Size of Conduit	In.	36	30	30	36	30	
Emergency Spillway							
Rainfall Volume (ESH) (areal)	In.	8.5	5.5	8.5	8.5	5.5	
Runoff Volume (ESH)	In.	5.02	2.68	4.43	4.90	2.24	
Type	veg.	220	65	170	95	100	
Bottom Width	Ft.	5.5	-	5.5	6.2	-	
Velocity of Flow (V)	Ft./Sec.	0.03	0.03	0.03	0.03	0.03	
Slope of Exit Channel	Ft./Ft.	659.7	654.8	603.7	613.5	595.5	
Max. Water Surface Elev.	Ft.						
Freeboard							
Rainfall Volume (FH) (areal)	In.	15.1	8.4	15.1	15.1	8.4	
Runoff Volume (FH)	In.	11.11	5.17	10.30	10.95	4.57	
Max. Water Surface Elev.	Ft.	664.0	658.0	607.0	620.0	598.7	
Capacity Equivalents							
Sediment Volume	In.	1.15	2.05	1.11	0.76	1.52	
Retarding Volume	In.	4.12	4.10	3.52	3.98	3.57	
Water Supply Volume	In.	.53	-	-	-	-	

1/ 50 year, except Structure 1 which is 100 years.

May 1969

TABLE 3A - STRUCTURAL DATA
CHANNELS

Beaverdam-Warrior Creeks Watershed, South Carolina

Channel	Station Numbering For Reach	Drainage Area (sq.mi.)	Capacity (cfs)		Hydraulic Gradient (ft/ft)	Channel Dimensions		Velocities 1/		Excavation (cu. yds.)
			Req'd	Design		Bottom (ft.)	Depth of Flow (ft.)	Aged (fps)	As Built (fps)	
Beaverdam Creek	302+00	0.35	213	213	0.00200	8	4.9	3.4	5.4	1,400
	310+00	1.30	224	224	0.00209	10	4.5	3.4	5.5	4,500
	344+00	1.83	296	296	0.00182	12	5.0	3.5	5.6	3,500
	371+50	2.61	306	306	0.00170	13	5.0	3.4	5.4	9,300
	426+00		Transition to Existing Channel							
Warrior Creek	149+00	7.27	444	444	0.00197	18	5.0	3.9	6.2	3,900
	175+00	9.27	474	474	0.00185	20	5.0	3.8	6.1	20,200
	241+00	9.84	564	564	0.00219	22	5.0	4.2	6.7	14,100
	284+50	10.77	564	564	0.00184	24	5.0	3.9	6.2	21,350
	338+00		Transition to Existing Channel							

1/ Side slopes = 1:1 n = 0.040 for aged channel and 0.025 for as built channels.
Type of improvement is channel enlargement.

May 1969

TABLE 4 - ANNUAL COST

Beaverdam-Warrior Creeks Watershed, South Carolina

(Dollars) 1/

Evaluation Unit	Amortization of Installation Cost 2/	Operation and Maintenance Cost	Total
Multi-purpose Str. 1, Floodwater Retarding Str. 2 and stream channel improvement on Beaverdam Creek	18,090	1,420 <u>3/</u>	19,510
Floodwater Retarding Strs. 4, 5, 33 and stream channel improvement on Warrior Creek	19,230	1,780 <u>4/</u>	21,010
Project Administration	4,770		4,770
TOTAL	42,090	3,200	45,290

1/ Price Base: Installation Cost - 1968, O&M - Adjusted Normalized.2/ Amortized at 4 7/8 percent interest rate for 100 years.3/ Includes \$105 for replacement of side inlets.4/ Includes \$120 for replacement of side inlets.

May 1969

TABLE 5 - ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE REDUCTION BENEFITS

Beaverdam-Warrior Creeks Watershed, South Carolina

Item	(Dollars) 1/ Estimated Average Annual Damage		Damage Reduction Benefit
	Without Project	With Project	
Floodwater			
Crop and Pasture	8,840	1,580	7,260
Other Agricultural	1,740	540	1,200
Non-agricultural	7,250	2,120	5,130
Subtotal	17,830	4,240	13,590
Sediment			
Overbank Deposition	3,650	670	2,980
Swamping	12,420	2,160	10,260
Subtotal	16,070	2,830	13,240
Indirect	2,650	600	2,050
TOTAL	36,550	7,670	28,880

1/ Price Base - Adjusted Normalized.

May 1969

TABLE 6 - COMPARISON OF BENEFITS AND COSTS FOR STRUCTURAL MEASURES

Beaverdam-Warrior Creeks Watershed, South Carolina

Evaluation Unit	(Dollars)						Average Annual Cost 2/	Benefit Cost Ratio
	Damage Reduction	More Intensive Land Use	Incidental	Secondary	Municipal Water	Redevelopment		
Multi-purpose Str. 1, Floodwater Retarding Str. 2, and stream channel improvement on Beaverdam Creek	14,060	4,570	7,440 3/	5,360	7,500	2,980	19,510	2.2 to 1.0
Floodwater Retarding Strs. 4, 5, 33, and stream channel improvement on Warrior Creek	13,150	7,090	6,230 4/	6,080	-	3,410	21,010	1.7 to 1.0
Project Administration							4,770	
GRAND TOTAL	27,210 5/	11,660	13,670	11,440	7,500	6,390	45,290	1.7 to 1.0

1/ Price Base: Adjusted Normalized.

2/ From Table 4.

3/ Includes \$6,160 incidental recreation and \$1,280 increased land value.

4/ Includes \$4,310 incidental recreation and \$1,920 increased land value.

5/ In addition, it is estimated that land treatment measures will provide flood damage reduction benefits of \$1,670 annually.

May 1969

TABLE 7 - CONSTRUCTION UNITS

Beaverdam-Warrior Creeks Watershed, South Carolina

(Dollars) 1/

Measures in Construction Unit	Annual Benefit	Annual Cost
1. Structure 1	17,170	13,470
2. Structures 1, 2, and Channel Improvement on Beaverdam Creek	41,910	21,720
3. Structure 5	17,240	8,680
4. Structure 4	5,440	5,155
5. Structure 33	6,330	4,840
6. Structures 4, 5, and Channel Improvement on Warrior Creek	29,630	18,730

1/ Price Base: Benefits - Adjusted Normalized
Installation Cost - 1968

May 1969

INVESTIGATIONS AND ANALYSES

Land Use and Treatment

Present land use was determined from soil and water conservation district reports, surveys, and field studies. Estimates of future land use and treatment measures were made by the District Conservationist, Area Conservationist, sponsors and other local people on the basis of their knowledge of the people, land, and present trends in the watershed. Needed land use adjustments based on soil capabilities were considered in arriving at the land treatment measures planned for the watershed.

The costs of installing the land treatment measures were developed by the Soil Conservation Service, the South Carolina State Commission of Forestry, and the U. S. Forest Service. Technical assistance costs were based on the present costs of the going district program, the going Cooperative Forest Management Program, and the going Cooperative Forest Fire Control Program. Costs of installing land treatment measures were based on present prices paid by landowners and operators in the locality. The amount of private forest land treatment measures needed to meet treatment goals was based on a field survey of the watershed adjusted for expected participation during the installation period.

Structures

Topographic maps, with five foot contour intervals, were made of the reservoir areas of all structures using a plane table and telescopic alidade. These maps were used to develop stage-area and stage-storage curves and are adequate for final design.

Floodwater retarding structures were designed in accordance with SCS Engineering Memorandum 27. Floodwater detention storage for each structure was determined by routing the 10 day hydrograph for the principal spillway design storm using the computer. Discharge rates were held to near the minimum that would empty the pool within ten days. The emergency spillway and freeboard hydrographs were also routed using the computer or the method outlined in E&WP Technical Guide No. 8 of the South RTSC. The principal spillways and the emergency spillways were proportioned to determine the most economical structures.

Lockwood Greene Engineers, Inc., of Spartanburg, S. C., consultants for the town of Gray Court, determined the quantity and quality of municipal storage and provided the necessary data for the proposed municipal structure.

During the preliminary site investigation on Site 1, an SP material was found in the left section of the flood plain and left abutment. No permeability tests were made. A seepage analysis of the

site was made using Darcy's equation and a conservative permeability rate of 30 feet per day was used for this material. This information was used in the reservoir operation studies. Permeability tests to determine actual seepage rates and uplift pressures at the toe of the dam will be necessary during final design. Vertical relief wells may be necessary to relieve uplift pressures in the event that a detailed foundation investigation proves them to be excessive. The cost of vertical relief wells was included in the construction cost estimate.

Channels

Horizontal distances for channel design were established from a semi-controlled watershed map. Representative cross sections, based upon mean sea level, were used to establish the point where damage begins and to show existing channel features.

Channels were designed using Manning's formula and water surface profile data. The "n" values used for channel design were based on the recommendations contained in the National Engineering Handbook, Section 16, Chapter 6. These values were reduced to 0.025 to determine velocities for newly constructed channels. Channels were proportioned to blend into the existing channel without increasing the stage downstream. The design discharge is that discharge where damage begins. Channel stability was determined from a recent study of approximately 100 miles of existing channel enlargement in eight watershed projects in the Piedmont Area of South Carolina. Some of the variables considered were drainage area, discharge, gradient, velocity, soil classification and plasticity, vegetative cover, and rock ledges. The designed dimensions of the channels were compared with the present dimensions. These channels are stable and good vegetative cover was normally established during one growing season.

Information obtained from this study was used to plan the channel improvement for this watershed. The planned channel improvement compares with several of the watersheds studied which are stable and well vegetated. All planned channel improvement in this project will be stable with insignificant amounts of erosion.

Forestry

A systematic field survey showed ground cover, forest and hydrologic conditions and treatment needs. The survey, supporting data, and information from other agencies and forestry officials determined the amount of remedial measures needed. The effects of the proposed works of improvement on fire hazard and risk were analyzed. The measures recommended contribute to flood reduction and soil stabilization.

Fish and Wildlife

Representatives of the South Carolina Wildlife Resources Department determined the effect of the project on fish and wildlife resources in the area. It was determined that any losses from construction of the channel will be offset by the five reservoirs to be provided.

Hydraulic and Hydrology

An analysis of the watershed was made using procedures in the National Engineering Handbook, Section 4, Part 1, Watershed Planning. This analysis was used to develop physical data for the economic evaluation and design of proposed works of improvement.

The partial duration series of rainfall was developed using rainfall data from the U. S. Weather Bureau Technical Paper No. 40, "Rainfall Frequency Atlas of the United States".

The weighted average runoff curve numbers for the watershed and structures were determined by applying information obtained from local observation, the U. S. Forest Service, District Conservationist, and Soil Scientist to the procedures outlined in the National Engineering Handbook, Section 4, Part 1, Watershed Planning. Runoff was determined by applying rainfall amounts to the weighted average curve number.

The principal spillway, emergency spillway, and freeboard hydrographs were developed in accordance with Chapter 21 of the National Engineering Handbook, Section 4, Part 1, Watershed Planning. For the two-stage structures, the runoff from the five year, 24 hour rain was stored between low and high stages.

Water surface profile computations, using the I.B.M. 1130 Computer, were used to determine stage-discharge relationships for 32 representative cross sections. Stage-area flooded data, by depth increments, for these cross sections were also calculated by the computer.

The 1, 10, 30, 50, 100, and 400 percent chance storms were routed through 32 representative cross sections using the Convex method of routing by the I.B.M. 1130 Computer.

Reservoir operation studies were made on Structure 1. These studies were accomplished by use of the 1130 Computer and the following data:

1. Area-storage curves were developed for the structure.
2. The most critical drought period on record (calendar years 1952 through 1956) was selected for the study.

3. The U. S. Geological Survey stream gage records on Reedy River near Greenville, South Carolina, were used to obtain monthly inflow in inches.
4. The following records were used to compute the net evaporation from the reservoir surface:
 - a. U. S. Weather Bureau Class A pan records at Union, S. C.
 - b. U. S. Weather Bureau standard rain gage at Laurens, S. C.
5. A seepage rate of 0.2 feet per month was used.

The town of Gray Court requested that the site be analyzed to determine the most feasible storage for their needs. On the basis of these studies, they decided to store 255 acre feet of water. This storage will yield 2,130,000 gallons of water per day during the maximum use months of July, August and September. The Upper Laurens County Water District concurs with this storage volume.

Economics

Methods used in making the economic investigations and analyses followed those approved by the Soil Conservation Service in benefit-cost evaluation of land and water resource projects. Basic data were obtained from local farmers, agricultural workers, experiment stations, city officials, state highway officials, county officials, and Department of Agriculture publications.

Adjusted normalized prices were derived from data approved by the Interdepartmental Staff Committee, Water Resources Council on April 20, 1966. Adjusted normalized prices were used in all benefit computations as well as for operation and maintenance costs. Present (1968) prices were used for installation costs. The costs of all structural measures were amortized over a 100 year period, using 4 7/8 percent interest rate.

Owners and operators of flood plain were interviewed to determine present land use and yields, flood free yields, and anticipated land use and yields with various degrees of protection from floodwater and sediment damage. Yields used in the analysis are those expected with good management.

Road and bridge damage estimates were obtained from state and county highway engineers.

Floodwater, sediment, restoration of former productivity, and more intensive land use benefits were claimed on portions of 1,453

acres, the area flooded by the 10 year frequency - 24 hour storm. Caution was taken not to double count or duplicate benefits. This was accomplished by computing restoration of former productivity and more intensive land use benefits on only that portion of the 1,453 acres of flood plain on which sediment damages were not evaluated. Sediment damage reduction benefits were estimated on the basis of increased net income which is expected to accrue as a result of recovery of land damage. An equivalent of 794 acres damaged 100 percent by sediment and erosion was used as the basis for deriving these benefits. Consideration was given to the degree of recovery that can be expected and the probable time required for recovery. Total damage reduction benefits due to structural measures are estimated to be \$27,210 annually.

Restoration of former productivity and more intensive land use benefits were claimed in those areas where reduction in flooding would warrant increased expenditures for higher producing land. Restoration of former productivity was estimated on the basis of flood free yields. More intensive land use benefits of \$11,660 were estimated on the basis of increased net income due to increased production resulting from the reduction of flood hazards.

The soils of the flood plain are mostly Class IIIw with areas of Classes IIw and IVw. The planned land use is within the capabilities of the flood plain soils.

Indirect damages were estimated to be 10 percent of direct flood-water and sediment damages to agricultural land, crops and pastures, roads and bridges, and other fixed improvements.

Municipal water benefits of \$7,500 annually were estimated by Lockwood Greene Engineers, Inc., representing the town of Gray Court. These benefits were checked for reasonableness and to determine if they exceeded the cost, in accordance with Chapter 8 of the Economics Guide and Paragraph 109.06 of the Watershed Protection Handbook.

Benefits from incidental recreational use have been claimed for all structures. Benefits valued at \$1.00 per visitor day were estimated to accrue at the rate of 65 visitor days per surface acre per year for all sites. Non-project associated costs to allow for construction and maintenance of proper sanitation measures, access roads, liability insurance, and other necessary recreational facilities were deducted. These costs are expected to amount to \$1,160 annually. After allowing for associated costs and discounting for sediment accumulation, incidental recreation benefits will amount to \$10,470 annually. Enhanced land values that will come about as a result of the project were derived by comparing the present value of building sites with utilities in the immediate area with the value of the same type property with a waterfront boundary. A net increase of \$1,300 each for 50 lots amounted to \$65,000. This was amortized at 4 7/8

percent interest for 100 years, to arrive at an average annual benefit from enhanced land values of \$3,200. This results in total incidental benefits of \$13,670 annually.

The sponsors estimated the value of land rights for structural measures at \$107,070. Included in this amount is \$8,800 for legal fees and time spent by sponsors in obtaining and recording easements.

Redevelopment benefits were estimated in accordance with Chapter 12 of the Economics Guide and Paragraph 102.02212 of the Watershed Protection Handbook. Wage payments to local labor during construction was estimated to be 20 percent of the construction costs. This value was amortized at $4 \frac{7}{8}$ percent interest for 100 years to arrive at annual redevelopment benefits from this source. Fifty percent of the annual operation and maintenance cost was used as the value of annual wages paid to local labor. This value was treated as a decreasing annuity for 20 years at $4 \frac{7}{8}$ percent interest and converted to an annual equivalent over the project life. Total redevelopment benefits amount to \$6,390 annually.

Local secondary benefits were estimated in accordance with Paragraph 102.02213 of the Watershed Protection Handbook and Chapter 11 of the Economics Guide. The value of local secondary benefits stemming from the project was estimated to be 10 percent of the direct primary project benefits. Indirect benefits were excluded when computing secondary benefits. The value of local secondary benefits induced by the project were estimated to be 10 percent of the increased costs that primary producers will incur in connection with increased or sustained production. Total local secondary benefits amount to \$11,440 annually.

Secondary benefits from a national viewpoint were not considered in the evaluation of the project.

Geology

Detailed field studies were made in the watershed after reviewing existing geologic reports and maps. Preliminary investigations of structure sites were made. Hand auger borings were made on Sites 1, 5, and 33. Due to a proposed long, wide and deep emergency spillway cut on Site 1, additional borings were made with a Failing CFD-2 power auger.

During the preliminary site investigation of Site 1, the municipal site, an SP material was found in the left section of the flood plain and left abutment. No permeability tests were made. A seepage analysis was made using Darcy's equation. A conservative permeability rate of 30 feet per day for this material was used, resulting in a seepage loss of approximately 0.2 foot of reservoir area per month. Permeability tests to determine actual seepage rates and uplift

pressures at the toe of the dam will be necessary during final design.

The predominant rock type in the watershed is granite. Biotite pegmatites are numerous in the ridge areas adjacent to Beaverdam and Warrior Creeks. Ample borrow of suitable quality for construction appears to be available in the immediate vicinity of all proposed structures. There are no noticeable geologic characteristics considered detrimental to the construction and functioning of the five proposed structures.

Estimates of sediment storage needed were made in accordance with procedures outlined in Technical Release No. 12, "Procedures for Computing Sediment Required for Retarding Reservoirs", U. S. Department of Agriculture, Soil Conservation Service, January 1968. Sheet erosion is a problem on approximately 300 acres of pasture and cultivated land in the upper part of the watershed. The average soil loss off of these critical areas is approximately 25 tons per acre per year. The allowable soil loss for these areas is approximately three tons per acre. It is anticipated that following application of needed land treatment measures the soil loss from these areas will be no greater than three tons per acre. The mining of vermiculite from open pits above structures could contribute significant amounts of sediment to the structure. However, discussion of future mining operations with representatives of W. R. Grace and Co., Zonolite Division, indicates that only Structure 4 will be affected. The sediment yield to Structure 4 was adjusted to allow for this additional sediment. Future mining was also considered in the testing of proposed channel design with a bed-load transport equation.

Estimated sediment storage volumes were based on a unit weight of 64 pounds per cubic foot for submerged sediment and 86 pounds per cubic foot for aerated sediment. The submerged unit weight was based on reservoir sedimentation surveys of similar areas. The aerated unit weight was estimated to be equal to the dry unit weight determined from upland samples. The variation in estimates of sediment distribution in the five flood storage areas is 10 to 20 percent. These estimates were based on delivery ratios, shape and size of reservoirs, entry slopes, and texture of sediment. The average annual sediment yield to the five structures was computed to be 15 acre feet, or an average of 0.63 acre feet per square mile.

It is estimated that the present sediment yield at the mouth of Beaverdam Creek is 17,500 tons per year and 16,400 tons per year at the mouth of Warrior Creek.

A test of the proposed channel design was made with a bed-load transport equation for a two year frequency storm. On Beaverdam Creek, slight degradation is suggested below Structure 1 to Station 604+50. No analysis was made from Station 604+50 to Station 685+50. Streamflow

in this reach is practically all on a rock foundation. Aggradation is suggested from Station 685+50 to the outlet.

On Warrior Creek degradation is suggested below Structure 5 to U. S. Highway 221. Below Structure 4 to Warrior Creek slight degradation is suggested. From U. S. Highway 221 to Station 372+50 moderate aggradation is suggested. From Station 372+50 to Station 482+50 degradation is suggested. From Station 482+50 to the outlet streamflow is on rock.

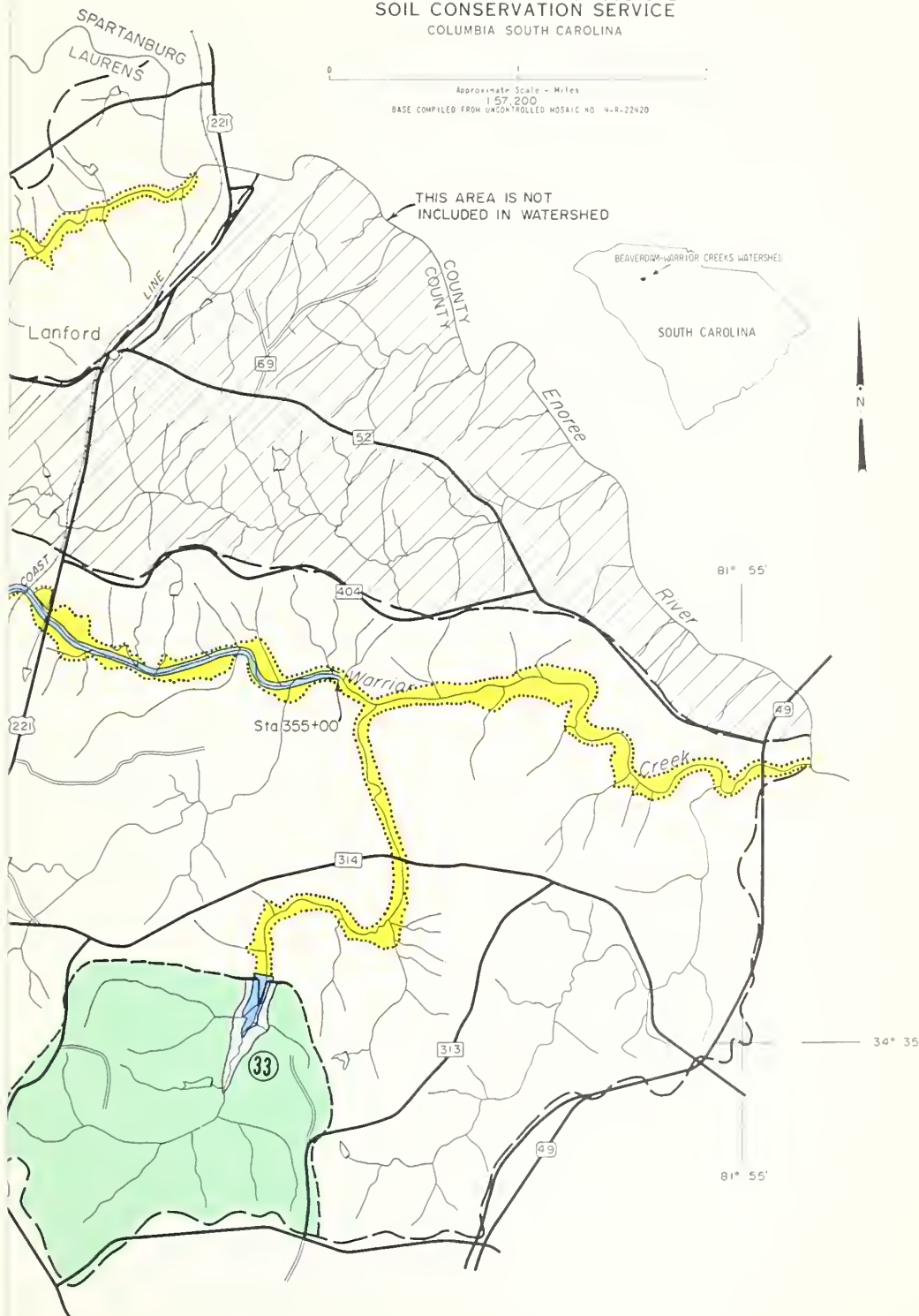
Investigations were made to determine the nature and extent of physical damage to the flood plain. Consideration was given to agronomic and other land treatment practices, crop yields, and soil capabilities. Aerial photos were studied by stereoscope to delineate flood plain and locate obvious damage areas. In order to delineate flood plain and locate representative cross sections, the flood plains were investigated in the field. Hand auger borings were used to estimate sediment damages. The severity of swamping was used to estimate swamping damages. Damages were summarized by evaluation reaches and adjusted for recoverability of productive capacity. Estimates of recoverability were developed from field studies and interviews with farmers. Calculations of reduction in sediment yield due to the project by incremental drainage areas were used to estimate reductions in damages brought about by structural and land treatment measures. Reduction in damage for channel improvement was based on total floodwater reduction computations.

PROJECT MAP

BEAVERDAM-WARRIOR CREEKS WATERSHED

LAURENS COUNTY, SOUTH CAROLINA

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
COLUMBIA SOUTH CAROLINA



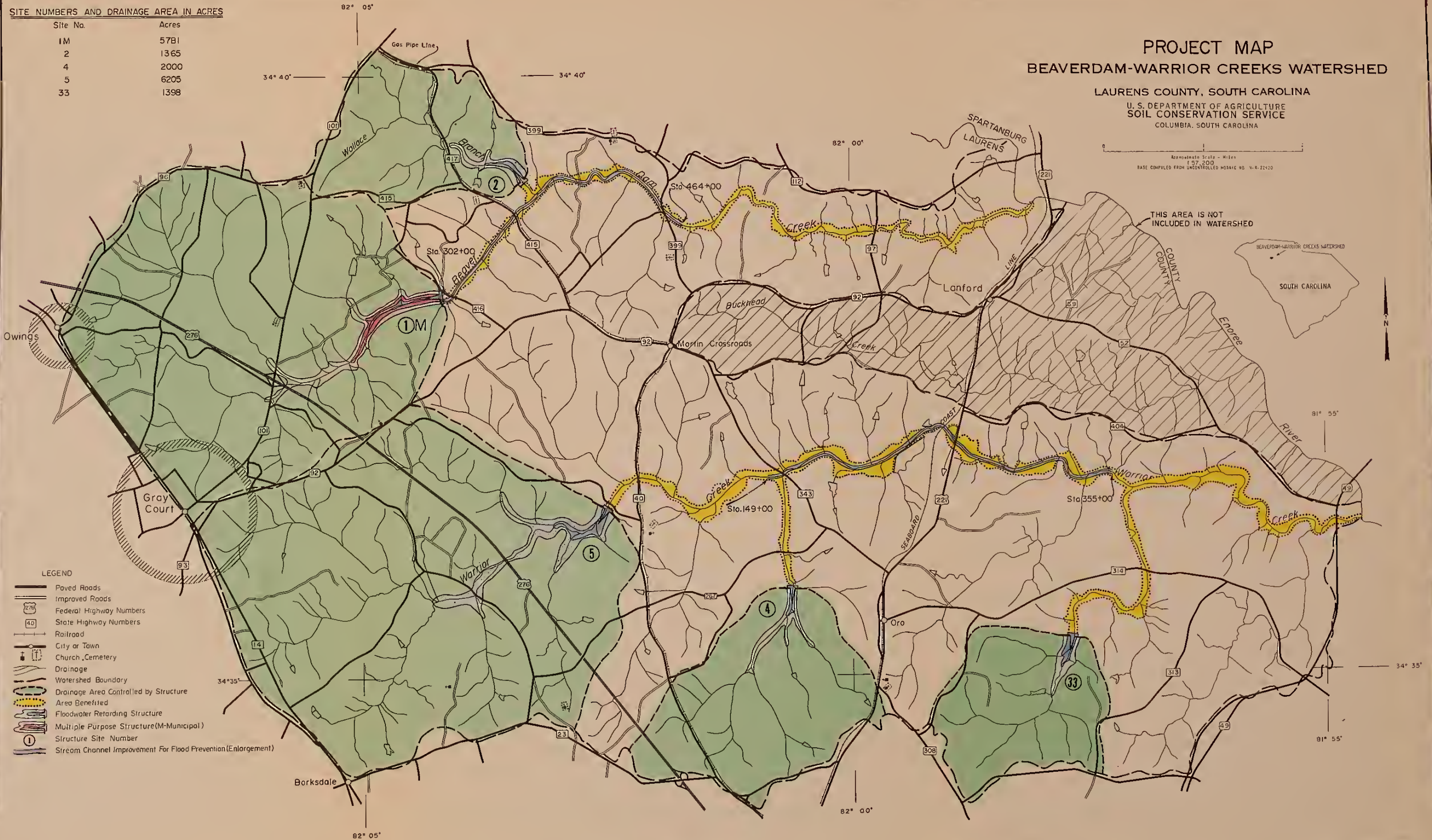
SITE NUMBERS AND DRAINAGE AREA IN ACRES

Site No.	Acres
1M	5781
2	1365
4	2000
5	6205
33	1398

PROJECT MAP
BEAVERDAM-WARRIOR CREEKS WATERSHED

LAURENS COUNTY, SOUTH CAROLINA
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
COLUMBIA, SOUTH CAROLINA

Approximate Scale - Miles
1 57,200
BASE COMPILED FROM UNCONTROLLED MOSAIC NO. 4-R-22420



BASE COMPILED FROM UNCONTROLLED MOSAIC NO. 4-R-22420

Rev 4-69 4-R-27905
Rev 5-69 4-R-22,428





